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STAR Towed Array Display Upgrade Contractor Report

Chris Widdis
Joe Hood
MacDonald Dettwiler and Associates Ltd.

MacDonald Dettwiler and Associates Ltd.
Suite 60, 1000 Windmill Road
Dartmouth, NS
B3B 1L7

Project Manager: Derek Burneett (902) 481-3539

Contract Number: W7707-052986/001/HAL

Contract Scientific Authority: J. Theriault (902) 426-3100 ext 376

Defence R&D Canada – Atlantic

Contract Report
DRDC Atlantic CR 2005-234
December 2005

Canada

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Author

Chris Widdis

Approved by

James Theriault

Scientific Authority

Approved for release by

Kirk Foster

DRP Chair

Abstract

This report documents the work done to enhance the Software Tools for Analysis and Research (STAR) by creating displays appropriated for data collected using towed arrays. The STAR software suite was developed to support general research and analysis objectives at Defence R&D Canada (DRDC) - Atlantic. Though relatively generic, many of the STAR displays had been tuned to meet the requirements of sonobuoy analysis with a single display pane displaying data from a single receiver / beam combination. Under this contract, three displays were added to aid in visualizing and analyzing large amounts of Energy Time Indicator (ETI) data on a single image. These summary displays provide a more intuitive view of the available information. New displays include a beam map display, a polar beam map display, and an on-demand beam clutter display. Each new display contains a single image with intensity represented by a grey-scale or colour-map. For the beam map display, the time varying intensity of all beams from a single receiver is shown. On the polar map display, monostatic or multistatic data is mapped onto a geographic display. The beam clutter display maps the time varying intensity from many pings for a single receiver / beam combination onto a single image. The last display previously existed, but it can now be generated “on-the-fly”. A number of display options are user-modifiable at run-time using a number of custom settings dialogues. Options include quantization selection, colour scale modification and interpolation, decimation and gridding algorithm selection, to name a few. Finally, a new method of outputting data to image based Surveillance Acoustics Plotting (SAPLOT) files were implemented. This new output format will simplify formatting of figures for reports and papers.

Résumé

Ce rapport décrit les travaux qui ont été effectués afin d’améliorer la suite STAR (Software Tools for Analysis and Research ou outils logiciels d’analyse et de recherche), en créant des visualisations appropriées pour les données recueillies au moyen de réseaux remorqués. La suite logicielle STAR a été développée afin d’appuyer les objectifs généraux de recherche et d’analyse de R&D pour la défense Canada (RDDC) – Atlantique. Bien qu’elles soient relativement générales, bon nombre des visualisations de STAR avaient été affinées afin de répondre aux besoins de l’analyse des signaux des bouées acoustiques au moyen d’un panneau unique affichant les données correspondant à une combinaison récepteur/faisceau unique. Dans le cadre du présent contrat, trois visualisations ont été ajoutées pour faciliter l’affichage et l’analyse, dans une image unique, de grandes quantités de données ETI (Energy Time Indicator ou indicateur énergie-temps). Ces visualisations récapitulatives présentent une vue plus intuitive des informations disponibles. Elles comprennent une visualisation cartographique des faisceaux, une visualisation cartographique polaire des faisceaux et, sur demande, une visualisation des échos parasites des faisceaux. Chaque nouvelle visualisation comporte une image unique dans laquelle l’intensité est représentée au moyen d’une carte en teintes de gris ou en

couleurs. Dans le cas de la visualisation cartographique des faisceaux, l'intensité de tous les faisceaux correspondant à un récepteur unique, qui varie en fonction du temps, est représentée. Dans la visualisation cartographique polaire, les données monostatiques ou multistatiques sont représentées sur une carte géographique. Dans la visualisation des échos parasites des faisceaux, l'intensité des impulsions multiples correspondant à une combinaison récepteur/faisceau unique, qui varie en fonction du temps, est représentée dans une image unique. La dernière visualisation existait déjà, mais elle peut maintenant être générée « à la volée ». Un certain nombre d'options de visualisation sont modifiables par l'utilisateur lors de l'exécution, au moyen de boîtes de dialogue qui autorisent des paramétrages personnalisés. Les options comprennent, pour n'en citer que quelques-unes, le choix de la quantification, de l'interpolation, de l'échelle des couleurs, de la décimation et de l'algorithme de quadrillage. Enfin, une nouvelle méthode de sortie des données dans des fichiers images SAPLOT (Surveillance Acoustics Plotting) a été mise en œuvre. Ce nouveau format de sortie simplifiera le formatage des graphiques dans les rapports et les documents.

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Executive summary

Introduction

This report details the enhancements made to two existing software packages to enable the more efficient analysis of towed array data. The Software Tools for Analysis and Research (STAR) and Signal Processing Packages (SPPACS) required enhancements. The STAR suite is implemented using the Interactive Data Language (IDL), though the design is not restricted to IDL and was first intended for analysis of sonobouy data. Applications in the STAR suite are built using a combination of reusable and custom components that meet the requirements of each application. The layered design and common components allow for rapid and logical development of new capabilities. Underlying STAR, SPPACS is used to perform much of the signal processing tasks. SPPACS is a group of software programs that are based on the C programming language. Each program provides a specific processing function and a series of programs can be chained together to create a custom-processing stream using the command line or scripts. Though SPPACS contained many towed-array specific functions, STAR lacked some important capability to display towed array data in an intuitive manner.

Results

The work carried out under this contract enhanced the STAR package by creating displays appropriated for data collected using towed arrays. Under this contract, three displays were added to aid in visualizing and analyzing large amounts of Energy Time Indicator (ETI) data on a single image. These summary displays provide a more intuitive view of the available information. New displays include a beam map display, a polar beam map display, and an on-demand beam clutter display. Each new display contains a single image with intensity represented by a grey-scale or colour-map. For the beam map display, the time varying intensity of all beams from a single receiver is shown. On the polar map display, monostatic or multistatic data is mapped onto a geographic display. The beam clutter display maps the time varying intensity from many pings for a single receiver / beam combination onto a single image. The last display previously existed, but it can now be generated “on-the-fly”.

Significance

The STAR/SPPACS combination has served as a useful and extendable tool for the analysis of acoustic and non-acoustic data. This contract has filled a gap in its capability to analyze/display towed array data. This will significantly improve the ability to quickly analyzed towed array data.

Widdis, Chris and Joe Hood. 2005. *STAR Towed Array Display Upgrade*. DRDC Atlantic CR 2005-234. Defence R&D Canada - Atlantic.

Sommaire

Introduction

Ce rapport décrit les améliorations apportées à deux logiciels existants afin de permettre une analyse plus efficace des données des réseaux remorqués. Il était en effet devenu nécessaire d'améliorer les logiciels STAR (Software Tools for Analysis and Research ou outils logiciels d'analyse et de recherche) et SPPACS (Signal Processing Packages ou logiciels de traitement du signal). La suite STAR est mise en œuvre au moyen du langage IDL (Interactive Data Language), bien que sa conception ne soit pas restreinte à ce langage, et elle a été élaborée en premier lieu pour l'analyse des données des bouées acoustiques. Les applications de la suite STAR sont développées au moyen d'une combinaison de composantes réutilisables et personnalisées qui répondent aux besoins particuliers de chaque application. Cette conception en couches ainsi que l'utilisation de composantes communes permettent de développer de nouvelles capacités rapidement et de façon logique. SPPACS, qui est sous-jacent à STAR, prend en charge la plus grande partie des tâches de traitement du signal. SPPACS est un groupe de logiciels programmés en C. À chaque programme est dévolue une fonction de traitement spécifique, et on peut, à partir de la ligne de commandes ou de scripts, chaîner ensemble toute une série de ces programmes pour créer un flux de traitement personnalisé. Malgré que SPPACS intégrait bon nombre de fonctions propres au traitement des données des réseaux remorqués, STAR comportait d'importantes lacunes en ce qui concerne la visualisation intuitive de ces dernières.

Résultats

Les travaux effectués dans le cadre du présent contrat ont permis d'améliorer la suite STAR en créant des visualisations appropriées aux données recueillies au moyen de réseaux remorqués. Dans le cadre de ce contrat, trois visualisations ont été ajoutées pour faciliter l'affichage et l'analyse dans une image unique de grandes quantités de données ETI (Energy Time Indicator ou indicateur énergie-temps). Ces visualisations récapitulatives présentent une vue plus intuitive des informations disponibles. Elles comprennent une visualisation cartographique des faisceaux, une visualisation cartographique polaire des faisceaux et, sur demande, une visualisation des échos parasites des faisceaux. Chaque nouvelle visualisation comporte une image unique dans laquelle l'intensité est représentée sur une carte en teintes de gris ou en couleurs. Dans le cas de la visualisation cartographique des faisceaux, l'intensité de tous les faisceaux correspondant à un récepteur unique, qui varie en fonction du temps, est représentée. Dans la visualisation cartographique polaire, les données monostatiques ou multistatiques sont représentées sur une carte géographique. Dans la visualisation des échos parasites des faisceaux, l'intensité des impulsions multiples correspondant à une combinaison récepteur/faisceau unique, qui varie en fonction du temps, est représentée dans une image unique. La dernière visualisation existait déjà, mais elle peut maintenant être générée « à la volée ».

Importance des résultats

La combinaison STAR/SPPACS constituait déjà un outil utile et extensible d'analyse des données acoustiques et non acoustiques. Ce contrat a permis de combler une lacune dans sa capacité d'analyser et de visualiser rapidement les données des réseaux remorqués.

Widdis, Chris et Joe Hood. 2005. *STAR Towed Array Display Upgrade*. RDDC Atlantique CR 2005-234. R & D pour la défense Canada - Atlantique.

Table of contents

List of figures

List of tables

2. Introduction

This final report outlines the work done by MacDonald Dettwiler and Associates Ltd. (MDA) in fulfillment of the STAR Acoustic Analysis Package: Towed Array Display Upgrade, Contract No. W7707-052986/001/HAL. This work was performed for DRDC Atlantic under the direction of the Scientific Authority (SA), James Theriault, from approximately August 2005 to September 2005.

2.1 Overview

The objective of this call-up was to generate displays in the STAR software suite to meet the needs of towed array data analysis. This was performed by reusing generic components in the STAR package and creating new reusable components where needed. Three displays were added to the software package: a beam map display, a polar beam map display, and a ping clutter (history) display.

This contract owes much of its success to the software reuse philosophy used within the STAR software suite. Many components utilized in the new displays were either completely reused, or simply tweaked to meet the needs of this contract. Software development on this contract continued with the reuse philosophy by creating and upgrading reusable components that future contracts can make use of.

This report is broken into five main sections. The remainder of this section provides background on the software suites used and modified during the contract. Section 3 provides an overview of the contract's requirements and work performed to meet those requirements. Section 4 includes a list of suggestions for future work. Section 5 details software configuration management processes and the versions used for this call-up. Section 6 provides a summary of current software issues.

2.2 Background

The required software development was performed using two software suites: STAR and Signal Processing Packages (SPPACS). The STAR suite was modified during this contract and SPPACS was used to process data for testing and tuning of the STAR software. An overview of the two software suites is provided in the following subsections.

The STAR and SPPACS suites are configuration controlled using the concurrent versioning system (CVS), and issue and enhancement idea tracking is affected using the Bugzilla issue tracking software. CVS is a repository that allows developers to check-in revisions to software and documentation where they are archived in a common database. The tool allows all previous versions of the software to be maintained and aids resolution of new issues, while ensuring that current builds of the software are readily accessible to users and developers alike. Bugzilla is a web accessible database that offers both user and developer input to issues, priorities and solutions. It provides coherent tracking and recording of an issue over its entire lifecycle.

STAR and SPPACS components are documented in a combination of formats, each with their own purpose. Microsoft Word documents are maintained, which describe functionality and algorithms of components. These are primarily intended for the end user. Enterprise Architect (EA) files are maintained, which document software design, interaction and dependencies. EA design information is intended primarily for developers. Hypertext Markup Language (HTML) library

documentation is being developed, which provides automatic extraction of the routine's Application Program Interface (API), purpose and description. This documentation is maintained to assist developers in familiarizing themselves with the existing libraries and components, and is intended to support and encourage software reuse. Some users may also wish to refer to this information for use in their own custom applications. SPPACS also provides HTML and man page user documentation for each module.

The most current status of the SPPACS and STAR suites can be found at https://star.iotek.ns.ca. Users are also encouraged to refer to the electronic documentation provided with the software distribution for up-to-date information.

2.2.1 STAR

The STAR suite was developed to support general research and analysis objectives at DRDC Atlantic. The primary objectives of the STAR suite are:

- Provide scientific grade analysis tools that allow for efficient, detailed quantitative and qualitative analysis of a data set.

- Support synergy between DRDC groups and the Department of National Defence (DND) by providing a common software base for analysis. This synergy encourages inter-group communication and simplifies user training, analysis process development, documentation and data portability.

- Support cost and analysis efficiency by providing software reuse and common tools and data formats. Examples of efficiency would be using the output of analysis from one group to feed the inputs of another, or using common software components to lower development cost of several custom analysis tools.

All STAR components are currently implemented using Interactive Data Language (IDL), though the design is not restricted to IDL. The name STAR reflects the generic nature of the software. Applications in the STAR suite are built using a combination of reusable and custom components that meet the requirements of each application. The layered design and common components allow for rapid and logical development of new capabilities. Though currently focused on sonar data processing and analysis, the tools are capable of expanding to meet other analysis and research requirements.

2.2.2 SPPACS

SPPACS is a group of software programs that are based on the C programming language and is implemented on Linux-based personal computers (PC). Each program provides a specific processing function and a series of programs can be chained together to create a custom-processing stream using the command line or scripts. The output from SPPACS is stored in DREA formatted data files. SPPACS has slowly evolved to its present day state due to the efforts of several MDA personnel over the last 4 years.

SPPACS has been used to perform a number of mid-trial and post-trial processing functions, such as the post-trial study of multistatic trial data and the mid-trial analysis of the Q265 sonobuoy test trial. SPPACS only performs data manipulation and does not provide an interface to examine the results. The processed data output is often imported into other applications that enable data display

and are used to perform the detailed analysis of the results. One example of such an application is the STAR suite.

The SPPACS software suite consists of two types of software. One type is runtime executables that can be used to process DRDC Atlantic data files in a number of ways, including data management and signal processing. Each program performs a specific function and the programs are designed so that they can be used in conjunction to perform more complex processing tasks. The software has proven to be very useful in simplifying data management and sonar processing tasks by providing a set of tools from which to build the necessary processing streams. These streams can be run from the command line or assembled into scripts to perform batch-processing tasks allowing for large amounts of data to be automatically processed. The second form of the software is a group of library functions that can be used by other programs to efficiently perform standard tasks. These library functions are extensively used by the runtime software, but can also used for other applications. There are now three types of libraries. The first are utility routines for performing tasks, such as header manipulation and command line parsing. The second are signal-processing modules termed Signal Processing Library (SPLIB). These are low-level modules, each performing a low level signal-processing task. A new SPPACS module typically consists of one or more SPLIB modules linked together with an SPPACS user interface. The final library type is a sonar-processing module termed sonar library (SONLIB). These are more complex modules that combine several SPLIB modules to create a complex sonar module, such as passive processing. Separating the SPLIB and SONLIB modules from SPPACS generated more generically reusable software. SPLIB and SONLIB are independent of the data header format, timestamping method, etc., and are suitable for integration in real-time processing systems.

SPPACS is also supported by a set of signal processing libraries known as the Fastest Fourier Transform in the West (FFTW). These free, open-source libraries provide optimized signal processing functions helping to ensure that the SPPACS software runs as efficiently as possible, while providing a significant reduction in coding effort.

3. Work Overview

This section presents an overview of the tasked work and how that work was completed. The Statement of Work (SOW) tasks for this contract are listed in Table 1 with the specific development requirements listed in Table 2. The following subsections describe how each task was completed. All requirements were successfully completed within the available contract funding.

Table 1. *Tasks*

TASK	DESCRIPTION
Task 1: Requirements Analysis and Design	The contractor shall meet with the SA to discuss detailed contract requirements prior to commencing work. During this meeting the SA will specify the trial data for analysis and work with the contractor to develop detailed requirements for the new displays described in Task 2.
Task 2: Implement Requirements	The contractor shall address the requirements, detailed in Table 2, and as prioritized by the SA, by developing SPPACS processing and enhancing the STAR Suite. The SA will indicate where algorithm and design review is required and the SA shall approve or provide those algorithms and designs prior to implementation.
Task 3: Perform Testing	The contractor shall develop test plans and test the software to the satisfaction of the SA and where possible, automate those tests to allow for rapid regression and installation testing. The SA shall have the option to review tests prior to testing.
Task 4: Software Maintenance and Design Improvement	As required, the contractor will troubleshoot and repair defects in the software. As time permits and as authorized by the SA, the contractor will examine the evolving software design and implement improved design features helping to ensure the long-term viability and reusability of the software. As required and as specified by the SA, the contractor will add enhanced functionality to the software within the limits of the contract funding.
Task 5: Maintain Configuration Management	The contractor shall implement configuration management of the IDL software using CVS and provide software deliverables by checking them into CVS and then demonstrating a successful checkout and run.
Task 6: Track Software Issues	The contractor shall use software issue tracking and resolution management using the Bugzilla issue-tracking tool. Web-based entry and review of issues from DRDC Atlantic shall be made available to the SA on the STAR Portal web site.
Task 7: Generate Documentation	The following details shall be documented in the contractor report: • As implemented algorithms and design • Testing performed • User interface changes

Table 2. Requirements

REQUIREMENT	ASSOCIATED REQUIREMENTS
Beam Map Display	The contractor shall enhance the ETI analysis display in the STAR to enable the operator to select a specific receiver for display as a beam map. The beam map will be generated in a new window using all available beams for that receiver. The beam map shall apply the current post-processing options prior to display. The beam map shall include a legend that shows the mapping of signal level to color. The beam map shall provide a settings dialogue with the SA selected options. These options will be identified during Task 1. The contractor shall work with the SA to determine the best method for re-sampling or re-scaling the beam map so that the bearing information is linear. If determined feasible, the beam map will be adjusted in this manner.
Display Capture	The contractor shall work with the SA to decide on a method of improving the utility of STAR output in scientific reports. This may include generation of SAPLOT output or formats other than PS. The contractor shall implement the desired output functionality, replacing the current method.
Polar Beam Map Display	The contractor shall enhance the Beam Map Display (implemented above) to enable the data to be plotted on a geo-referenced polar axis.
Beam Clutter Display	The contractor shall enhance the current STAR clutter displays to enable the display of multiple beams rather than multiple sonobuoys. This should be a minor enhancement.

3.1 Requirements Analysis and Design

The Project Engineer (PE) met with the SA several times throughout the contract to discuss detailed requirements and the implementation approach. BIMBO, a previously developed software package, was used as a reference for much of the algorithm design. Colin Calnan of XWAVE provided an overview of BIMBO operation and sample source code to the PE. Similar algorithms were selected for use in STAR. In particular, the method of beam to bearing conversion and bearing to geographic conversion (gridding) was modeled on the BIMBO implementation. BIMBO used FORTRAN and MATLAB, so direct reuse wasn't feasible.

Colin Calnan was also consulted during the specification of SAPLOT options for image-based displays. A draft specification was captured using email and the new output format was implemented as described in section 3.2.2.

The PE also met with the SA near the end of the contract to demonstrate the new displays and agree on modification. This included addition of new algorithms and tweaking of the default settings for existing algorithms. This resulted in STAR displays that contain significantly more functionality than their predecessor and are more fully integrated with the current analysis process and tools.

3.2 Implement Requirements

The following section describes how the requirements listed in Table 2 were implemented.

3.2.1 Beam Displays

A generic module was added to the STAR software package to generate images based on data being viewed in the parent display, this includes any post-processing that may have been applied to the data. This new module provides all the functionality needed by all three new displays, including a settings dialog, colour legend, and display capture functionality.

This new module was integrated into the existing ETI analysis window (Figure 1**)** so that data could be selected for transfer to the new displays. When a user activates a display function, then clicks on one of the plots in the ETI analysis window, the desired display is created for the selected receiver. In the case of beam map and polar map displays, the current time period is used. For clutter images, all pings marked with a main blast are used. The following sections give a brief description of how each display type is created. Please refer to the ETI display section of the STAR Analysis Technical Manual [1] for a more in depth description of the code design and the algorithms used.

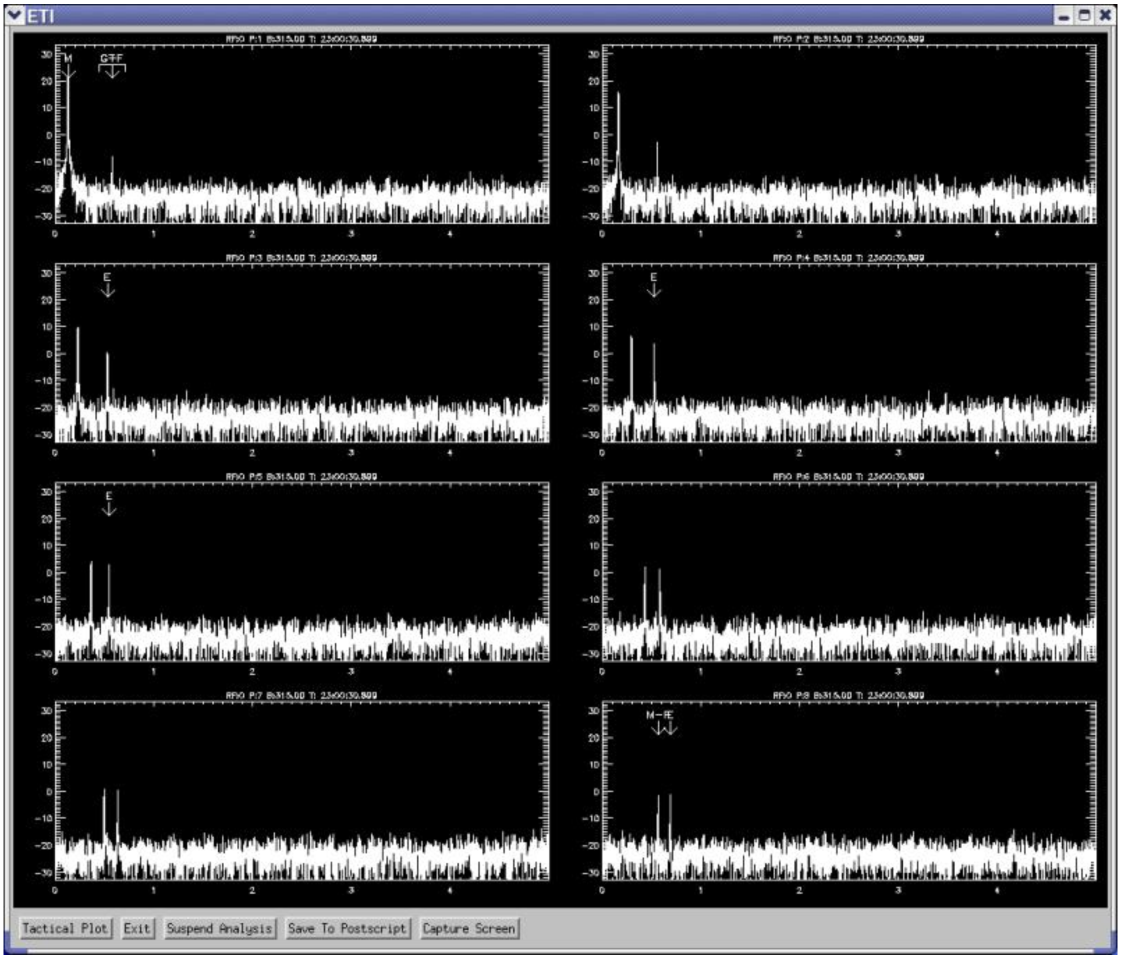

Figure 1. ETI Analysis Window

3.2.1.1 Beam Map Display

The beam map display maps time-varying intensity over bearing, with time on the y-axis and bearing on the x-axis. Figure 2 shows an example of the beam map display generated using synthetic data.

Two algorithms are needed to convert beam data for the beam map display: beam to bearing conversion and beam data to bearing data conversion. The algorithm used to convert beams to bearing is dependant on the settings for that receiver. Currently sine spaced beams, typically produced by towed arrays, and evenly spaced beams, typically produced by sonobuoys, can be used. Sine spaced beams can run over 180 or 360 degrees. The beam model for each receiver is specified in the track cross-reference table of the Non-Acoustic Data (NAD). Beam to bearing conversion uses a user-selectable algorithm to convert the beams into evenly spaced bearings. At the time of writing, two conversion methods were implemented: interpolation and nearest-neighbour. The interpolation algorithm can be further modified to use a number of common interpolation methods. The nearest-neighbour algorithm simply copies data from the closest beam into the data array for that bearing.

Time axis data is decimated for the display using the image canvas that Ors (peak picks) the data to compress it to the display size. User selectable decimation algorithms were not implemented for this display.

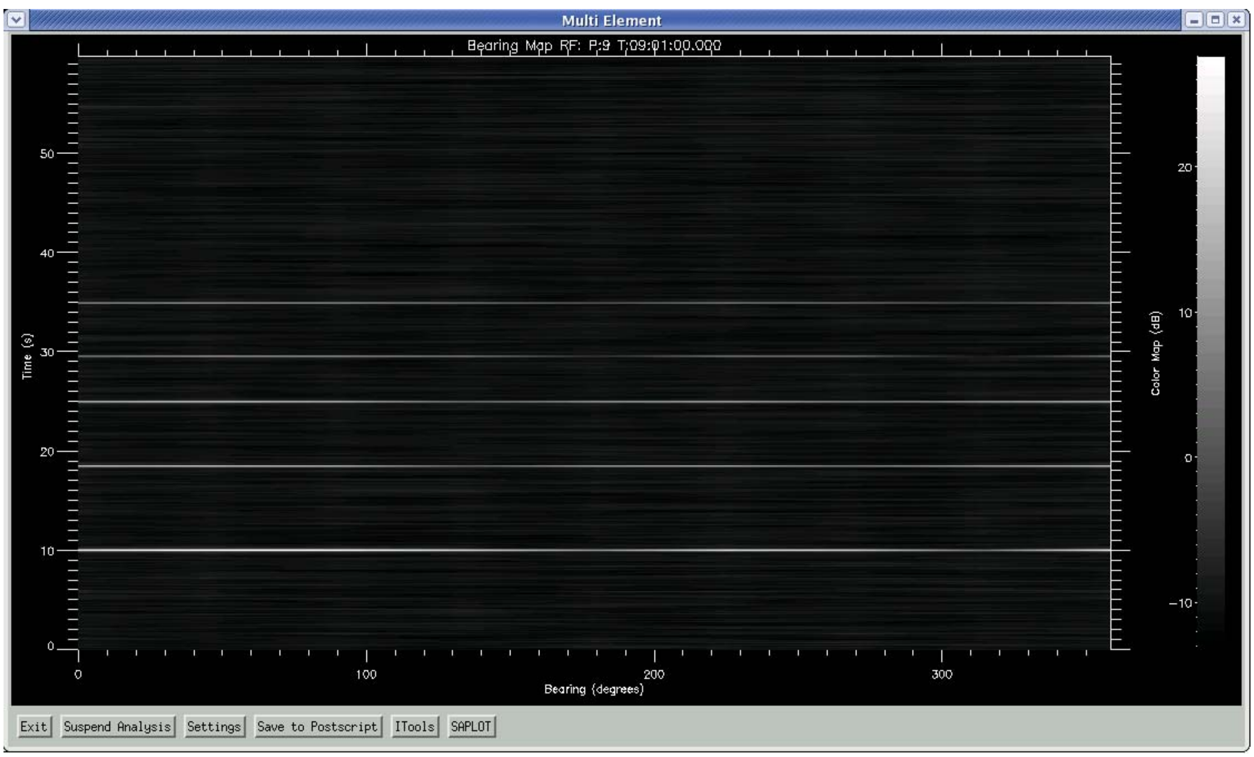

Figure 2. Beam Map Display for evenly spaced beams and linear interpolation

3.2.1.2 Polar Beam Map Display

The polar beam map display is an extension of the beam map display. The same options are available to transform beam-time data to bearing-time data, but decimation is also available. Decimation is performed before a conversion algorithm converts the bearing-time data points to geographical coordinates, then the data is remapped to an evenly spaced grid. An image is then generated using the grid data. Many of the available grid algorithms require a significant amount of memory and processing time to perform their calculations, therefore, a decimation algorithm was added to the processing chain to reduce the amount of data. Figure 3 shows an example of the polar beam map display using synthetic data.

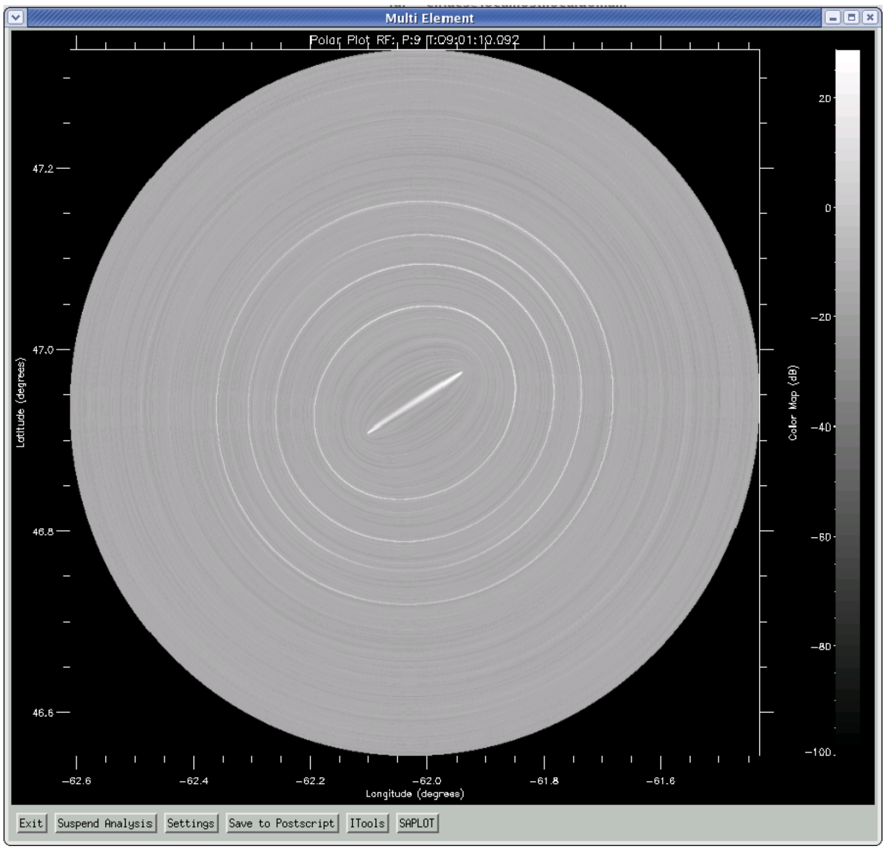

Figure 3. Polar Beam Map Display for synthetic multistatic data

3.2.1.3 Beam Clutter (History) Display

The ability to display multiple beams, rather than multiple receivers, was already provided for in the Clutter Display through data navigation window options; however, it had not been tested prior to this contract. Running the Clutter Display, and using the data navigation window to align the images by beam as opposed to by receiver, proved that this feature is functioning properly.

In addition, the ability to generate a Clutter Image directly from ETI data was implemented. This function reuses the display component generated for the aforementioned displays.

3.2.2 Display Capture

A new object-oriented reusable component was added to the STAR package that provides the capability to output images and plots to SAPLOT format. This contract utilized this object to produce bitmap and American Standard Code for Information Interchange (ASCII) text files based on the specification for SAPLOT images generated during requirements analysis. Basically, the image titles are output using standard SAPLOT entries and the image is described in the SAPLOT file by the image name, the axis endpoints and the axis units. A bitmap image is also saved for importation into the application that realizes and formats the SAPLOT image.

The IDL Itools package was investigated under this contract, however, after discussions with the SA, it was determined that this package was not mature enough to be suitable for display capture. RSI plans on improving the Itools functionality in the upcoming release of IDL 7.0, so the ability to launch Itools using the image data was left in the new software.

3.2.3 Software Reuse

Other capabilities used during this contract also came from reusable components generated during previous Noise Monitoring Software call-ups. Without these, it would have been impossible to provide an application with a structure as seen here. Some of the reusable components used include:

- Time: A simple library to handle manipulation and formatting of time based data. It also includes utility functions to convert to and from text, and DREA header formats.

- Map_position: A simple library to handle calculations related to map range and bearing calculations was used to generate the polar beam map.

- Tactical_database: This is the component that was used to parse, store and provide query access to receiver and source names. It allowed the application to run generically and simply fill in this data, as required.

- star_dialog_box: The star_dialog_box is an object-oriented approach to designing dialog boxes. Widgets used in IDL were previously wrapped into object-oriented modules, and the dialog box module simply provides a means to encapsulate a list of these objects, and a set of methods to simplify the creation and management of the dialog box.

These modules also have other capabilities that were not used during this contract, and still more modules were developed and tested so that they can be used in other work.

Several new reusable components were generated as part of this contract. Some of the new components include:

- star_algorithm_manager: The purpose of the star_algorithm_manager is to encapsulate a list of algorithms that the user can select and modify from a combo box or button group contained in a dialog box.

- star_image_canvas: The image canvas, which is the reusable component used as the bottom layer for most image graphic displays, was wrapped into a class under this contract to provide additionally required features and to simplify reuse.

- star_saplot: As described in section 3.2.2, an object oriented SAPLOT output module was created. This new component can be easily ported to other applications to generate SAPLOT compatible files.

3.2.4 Further Information

A detailed description of the technical aspects related to the work performed under this contract can be found in the primary STAR reference, "The Scientific Tools for Analysis Research – Data Analysis and Technical Manual" [1]. This document provides details, such as the algorithms used to perform the various analysis measurements, and documents the analysis process used to process and analyze the data for this call-up. The same process can be used for all work with STAR and it can offer significant improvements in efficiency, if followed. A soft copy of the most recent version of the document can be found in draft form in the distribution directory under acoustics/doc/analysis_tools/STAR_analysis_technical_manual.doc.

4. Suggestions for Improvement

As often occurs during contracts of this nature, a number of questions and ideas were generated. The most significant ones are documented here in the form of suggestions for further improvement and study.

Most of the new components created under this contract are object-oriented. The reason for this is that an object-oriented design lends itself more toward the design philosophy of the STAR software suite: simple software reuse and maintainability.

4.1 Object-Oriented Graphic Displays

STAR applications are built upon layers of code, where the bottom most layers are generic components used by many applications, and higher layers are specific to an application. Graphic displays are divided this way, where a generic image canvas, plot canvas or tactical plot canvas is used to control the output of data to the screen and files, while a custom canvas is created to handle events and customize the way the data is displayed. At the start of this contract these components were all functionally based, though they used an object-oriented design.

While the design previously described is very effective for code reuse, one problem came up during this contract. Additional features, such as the colour bar, needed to be added to the bottom layer image canvas, which could have affected other applications that used it. A class-based implementation would allow such additions to be added through subclasses, which would not affect other applications. This approach avoids cut-and-paste reuse and hard-coded function calls. Abstract method calls and inheritance could be used instead.

The process of porting the graphic displays to an object-oriented design was started under this contract. The generic image canvas was wrapped into an object named 'star_image_canvas', as described in section 3.2.3. The application specific canvas was then created as a subclass of the star_image_canvas, thereby reducing the amount of code needed in its implementation.

The next step is to create a higher-level canvas class that contains all the common code needed for any graphic display. The generic plot, image and tactical plot canvases could then be sub-classed from the canvas class, and the application layer of canvases would be subclasses of these three classes. This would significantly reduce the number of lines of code to maintain and simplify the generation of new canvas classes in the future.

4.2 Object-Oriented Algorithm Design

Under this contract, several families of object-oriented algorithms were created, including re-sampling, scaling, and beam conversion algorithms. Under another contract, another family of object-oriented algorithms was created to perform averaging and normalization operations.

The need for reusable components for object-oriented algorithms has become apparent. Some of these components have been created under this, and other, contracts, such as the dialog box and algorithm manager (section 3.2.3). Further development of these reusable components, such as base classes for all algorithms, would improve development time for future additions to these families, as well as the creation of new algorithm families.

4.3 Replace Start-up Scripts with Dialog Boxes

Each application uses a start-up script to configure a wide range of parameters for use in the application. A template for these start-up scripts is provided to the SA, who then modifies the contained parameters to suit their specific needs.

A possible improvement on this design would be to create a custom dialog box using the reusable dialog box component mentioned in section 3.2.3. The SA would then have a graphical user interface (GUI) to configure the analysis application. Options in this dialog box would include the ability to save and load configurations, and to modify the application parameters. This improvement would also allow the user to modify parameters such as the file to be used without exiting and restarting the application.

5. Maintain Configuration Management

STAR and SPPACS are maintained using CVS. The most recent release version is maintained and bug fixes are applied to that version, as required, ensuring that a stable release is always available. Simultaneously, software enhancements are applied to the development version and bug fixes are merged with this version. Once a contract nears completion, or a release of the software is otherwise required, a new release version is branched off of the development stream for final integration, release testing and delivery.

STAR (includes SPPACS) release 4.8 (tag star_release_4_8_0) was created under this contract to serve as a baseline for these additions.

6. Track Software Issues

Defect Tracking Systems allow users to keep track of outstanding bugs in their product effectively. STAR and SPPACS issue tracking is performed using a web accessible tool called Bugzilla. This tool can be accessed using a secure web interface at https://star.iotek.ns.ca. Once the appropriate security procedures, detailed on the web page, have been followed, users and developers can use this site to add, view or modify issues related to the software packages.

A breakdown of the current issues for the STAR and SPPACS distributions are shown in Table 3. The total number of unresolved issues is shown in the NEW/ASSIGNED/ REOPENED column. The total number of opened issues is broken into two classes of severity. Issues classified as BLOCKER/CRITICAL/MAJOR are issues that should be addressed in the short term. Blockers are always addressed immediately to ensure that the user community can continue with their work. Issues classified as NORMAL/ MINOR/TRIVIAL are issues that can be dealt with in the long term.

Table 3. *Distribution Issue Summary (28/09/2005)*

PRODUCT	NEW/ASSIGNED/ REOPENED (TOTAL)	BLOCKER/CRITICAL/ MAJOR	NORMAL/MINOR/ TRIVIAL
SPPACS	40	1	39
STAR	57	4	53

The following gives a more detailed description of the SPPACS BLOCKER/ CRITICAL/MAJOR column:

- Issue # 284 (major) **fails DAT32 byteswap case.** The utility is attempting to read the extra gains using the original header, which may be in a different byte-order than the platform.

The following list gives a more detailed description of the STAR BLOCKER/ CRITICAL/MAJOR column:

- Issue # 193 (critical) **tacplot does not cleanup before exiting**. The work around for this issue is to run heap_gc after the analysis window has closed.

- Issue # 107 (major) **problems capturing close button**. A solution exists for this but has only been incorporated into the tactical plot.

- Issue # 295 (major) **capture screen doesn't work correctly.** The Capture Screen button does a screen capture on the analysis window and not the tactical plot. If the tactical plot is closed and reopened this will work. A fix is available in the next release.

- Issue # 329 (major) **overlays need to be optimized.** The tactical plot is too slow (on Bender). To load on Bender (dual P4- 1 GHz), it takes approximately 20 seconds the first time and 15 to 20 seconds thereafter.

7. References

1. The Software Tools for Analysis Research – Data Analysis and Technical Manual – Revision 1/0, (/usr/local/atools/acoustics/src/analysis_tools/documents/STAR_analysis_technical_manual.doc) STAR Release 4.8

List of symbols/abbreviations/acronyms/initialisms

API	Application Programming Interface
ASCII	American Standard Code for Information Interchange
CVS	Concurrent Versioning System
DND	Department of National Defence
DRDC	Defence Research & Development Canada
DREA	Defence Research Establishment Atlantic
DRP	Document Review Panel
EA	Enterprise Architecture
ETI	Energy Time Indicator
FFTW	Fastest Fourier Transform in the West
GUI	Graphical User Interface
HTML	Hypertext Markup Language
IDL	Interactive Data Language
MDA	MacDonald Dettwiler and Associates Ltd.
NAD	Non-Acoustic Data
PC	Personal Computer
PE	Project Engineer
SA	Scientific Authority
SAPLOT	Surveillance Acoustics PLOTting
SONLIB	Sonar Library

SOW	Statement of Work
SPLIB	Signal Processing Library
SPPACS	Signal Processing Packages
STAR	Software Tools for Analysis and Research

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(U) This report documents the work done to enhance the Software Tools for Analysis and Research (STAR) by creating displays appropriated for data collected using towed arrays. The STAR software suite was developed to support general research and analysis objectives at Defence RDCanada (DRDC) − Atlantic. Though relatively generic, many of the STAR displays had been tuned to meet the requirements of sonobuoy analysis with a single display pane displaying data from a single receiver / beam combination. Under this contract, three displays were added to aid in visualizing and analyzing large amounts of Energy Time Indicator (ETI) data on a single image. These summary displays provide a more intuitive view of the available information. New displays include a beam map display, a polar beam map display, and an on−demand beam clutter display. Each new display contains a single image with intensity represented by a grey−scale or colour−map. For the beam map display, the time varying intensity of all beams from a single receiver is shown. On the polar map display, monostatic or multistatic data is mapped onto a geographic display. The beam clutter display maps the time varying intensity from many pings for a single receiver / beam combination onto a single image. The last display previously existed, but it can now be generated “on−the−fly”. A number of display options are user−modifiable at run−time using a number of custom settings dialogues. Options include quantization selection, colour scale modification and interpolation, decimation and gridding algorithm selection, to name a few. Finally, a new method of outputting data to image based Surveillance Acoustics Plotting (SAPLOT) files were implemented. This new output format will simplify formatting of figures for reports and papers.

(U) Ce rapport décrit les travaux qui ont été effectués afin d’améliorer la suite STAR (Software Tools for Analysis and Research ou outils logiciels d’analyse et de recherche), en créant des visualisations appropriées pour les données recueillies au moyen de réseaux remorqués. La suite logicielle STAR a été développée afin d’appuyer les objectifs généraux de recherche et d’analyse de RDpour la défense Canada (RDDC) – Atlantique. Bien qu’elles soient relativement générales, bon nombre des visualisations de STAR avaient été affinées afin de répondre aux besoins de l’analyse des signaux des bouées acoustiques au moyen d’un panneau unique affichant les données correspondant à une combinaison récepteur/faisceau unique. Dans le cadre du présent contrat, trois visualisations ont été ajoutées pour faciliter l’affichage et l’analyse, dans une image unique, de grandes quantités de données ETI (Energy Time Indicator ou indicateur énergie−temps). Ces visualisations récapitulatives présentent une vue plus intuitive des informations disponibles. Elles comprennent une visualisation cartographique des faisceaux, une visualisation cartographique polaire des faisceaux et, sur demande, une visualisation des échos parasites des faisceaux. Chaque nouvelle visualisation comporte une image unique dans laquelle l’intensité est représentée au moyen d’une carte en teintes de gris ou en couleurs. Dans le cas de la visualisation cartographique des faisceaux, l’intensité de tous les faisceaux correspondant à un récepteur unique, qui varie en fonction du temps, est représentée. Dans la visualisation cartographique polaire, les données monostatiques ou multistatiques sont représentées sur une carte géographique. Dans la visualisation des échos parasites des faisceaux, l’intensité des impulsions multiples correspondant à une combinaison récepteur/faisceau unique, qui varie en fonction du temps, est représentée dans une image unique. La dernière visualisation existait déjà, mais elle peut maintenant être générée « à la volée ». Un certain nombre d’options de visualisation sont modifiables par l’utilisateur lors de l’exécution, au moyen de boîtes de dialogue qui autorisent des paramétrages personnalisés. Les options comprennent, pour n’en citer que quelques−unes, le choix de la quantification, de l’interpolation, de l’échelle des couleurs, de la décimation et de l’algorithme de quadrillage. Enfin, une nouvelle méthode de sortie des données dans des fichiers images SAPLOT (Surveillance Acoustics Plotting) a été mise en œuvre. Ce nouveau format de sortie simplifiera le formatage des graphiques dans les rapports et les documents.

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